CHAPTER IX

COMMERCIAL SPACE TRANSPORTATION

The Federal Aviation Administration's (FAA) Associate Administrator for Commercial Space Transportation (AST) licenses and regulates U.S. commercial space launch activity as authorized by Executive Order 12465, *Commercial Expendable Launch Vehicle Activities*, and 49 US Code, Subtitle IX, Chapter 701 (formerly the *Commercial Space Launch Act)*. AST's mission is to license and regulate commercial launch and reentry operations to protect public health and safety, the safety of property, and the national security and foreign policy interests of the United States. In addition, the FAA licenses commercial launch and reentry sites. The *Commercial Space Launch Act of 1984* and the 2004 *U.S. Space Transportation Policy* also direct the DOT (FAA) to encourage, facilitate, and promote commercial launches.

INTRODUCTION TO COMMERCIAL SPACE TRANSPORTATION

WHAT IS COMMERCIAL SPACE TRANSPORTATION?

The term "commercial space transportation" refers to the launch of an object into space or the reentry of an object from space by a private, non-government entity. Typically, commercial space transportation concerns the activities of launch service providers – companies that place satellites into orbit under contract from corporations, governments, universities, or other organizations. Launch service providers also conduct suborbital flights, which are typically short duration launches of objects high into the atmosphere or into space that return to Earth instead of entering orbit. The world's major orbital launch service providers are in the United States, Europe, Russia, and China. Other countries are attempting to enter the market such as Brazil, Japan, and India.

The FAA issues licenses to companies that conduct commercial launches in the United States and to U.S. companies that conduct launches outside U.S. territory. U.S. orbital

launch service providers include Lockheed Martin's International Launch Services (ILS), Boeing Launch Services (BLS), Orbital Sciences Corporation (OSC) and Space Exploration Technologies (SpaceX). Active U.S. commercial suborbital launch providers include DTI Associates and Scaled Composites, LLC. A launch license from FAA/AST may be required for certain large hobby or research rockets, depending on the rocket's motor impulse, operating time, and ballistic coefficient factors.

Suborbital launches by private entities are an increasingly important regulatory activity for the FAA. Several organizations are developing reusable suborbital vehicles designed to carry people or payloads to and from very high altitudes. The following sections will briefly describe the history of the commercial use of space, U.S. orbital launch service providers, and the emerging suborbital service providers using new reusable vehicles.

COMMERCIAL USE OF SPACE

Since the launch of Sputnik in 1957, spaceflight has largely been a government endeavor. Even though satellites serving commercial or quasi-commercial purposes went into service in the early 1960s, the business of launching them was a government affair. Many of the early commercial satellites launched were telecommunications spacecraft located in geosynchronous Earth orbit[1] (GEO) used to relay video and audio signals for television and telephone services.

Launches of satellites that serve commercial purposes have steadily increased from the early 1980s to the late 1990s. In 2004, commercial launches represented about 30 percent of the total orbital launches conducted worldwide. Until the mid-1990s, commercial satellites were almost exclusively telecommunications satellites located in GEO.

Since 1997, new satellite markets have opened up for commercial mobile telephones, data messaging, and remote sensing in low Earth orbit (LEO) or other non-geosynchronous orbits (NGSO).[2] Digital satellite radio services began in North America in late 2001.

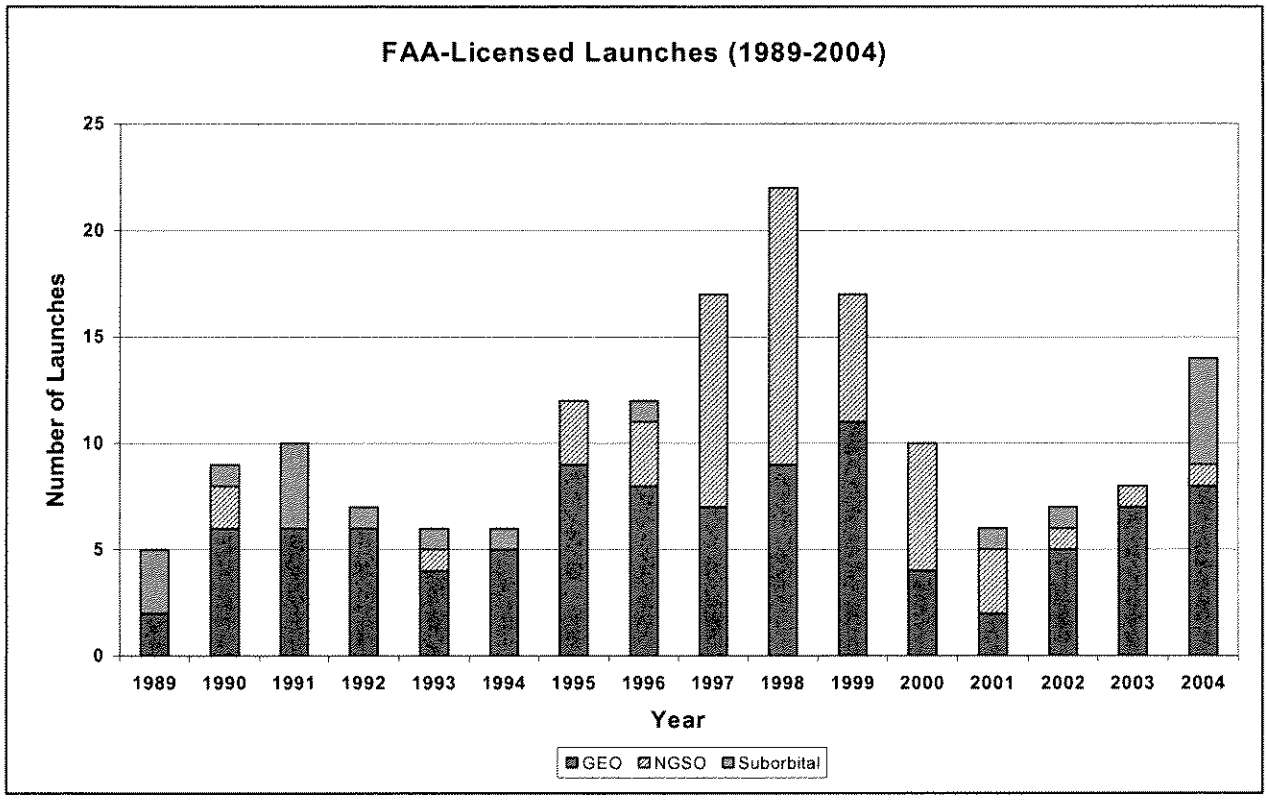
The era of public space travel and tourism has arrived. The first privately-built launch vehicle to carry humans into space launched three times in 2004 into space on suborbital flights from Mojave, California. New companies developing passenger-carrying vehicles are expected to begin regular suborbital flights around 2007. In addition, a new $50-million private sector prize contest has been announced for passengers to low Earth orbit.

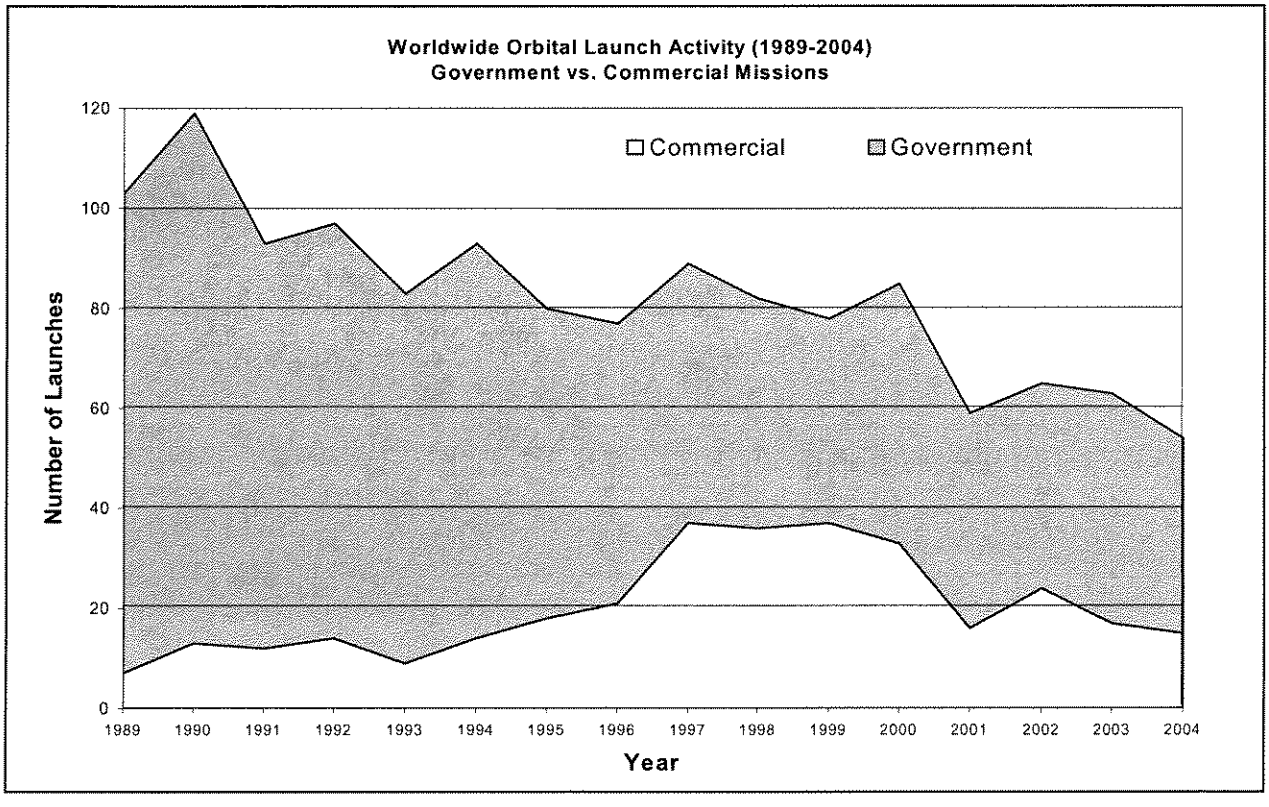
U.S. COMMERCIAL LAUNCH SERVICES

Up until the early 1980s, all commercial satellites were launched on rockets owned and operated by the U.S. government, including the Space Shuttle. When Europe's Arianespace began offering launch services for commercial satellites in 1983, an international launch market was created and has since grown to over 15 vehicle families worldwide.

[1]A spacecraft in geostationary Earth orbit is synchronized with the Earth's rotation, orbiting once every 24 hours, and appears to an observer on the ground to be stationary in the sky. GEO is a broader category used for any circular orbit at an altitude of 35,852 kilometers with a low inclination (i.e., over the equator).

[2]Non-geosynchronous orbit (NGSO) satellites are those in orbits other than GEO. They are located in LEO (lowest achievable orbit to about 2,400 kilometers), medium Earth orbit (MEO, 2,400 kilometers to GEO), and all other high or elliptical orbits or escape trajectories.


FAA-Licensed Launches (1989-2004)
Number of Launches
25
20
15
10
5
0
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
Year
GEO
NGSO
Suborbital


Worldwide Orbital Launch Activity (1989-2004)
Government vs. Commercial Missions
Number of Launches
120
100
80
60
40
20
0
Commercial
Government
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
Year

Following the passage of the *Commercial Space Launch Act of 1984,* the U.S. government and industry began to transition from government to commercial operations for expendable launch vehicles (ELVs). The *Commercial Space Launch Act* authorized the Department of Transportation (DOT) to regulate and license commercial launch activities. From 1989 through the end of 2004, the DOT has licensed 168 orbital and suborbital commercial launches.

NASA and the U.S. Air Force continue to launch government satellites, which include flights of the Space Shuttle. These flights are not considered commercial by the FAA because they are conducted for and by government agencies and not by the private launch service provider, even though the same vehicles may be used. Occasionally, a U.S. government agency may contract a private launch service provider to deploy a satellite, or may contract a satellite manufacturer to build a satellite and deliver it in orbit, allowing the manufacturer to select a private launch service provider. As a result, launches of U.S. government payloads may or may not be FAA-licensed as commercial depending on who is conducting the specific launch. Launches of foreign government satellites on U.S. vehicles are commonly contracted through the private service providers and are considered commercial.

Launch providers continually upgrade their vehicles to keep pace with the marketplace and technology and retire older models.

Currently active ELVs that are licensed by the FAA for orbital launches include:

- Atlas 5 (heavy class), built by Lockheed Martin and marketed by International Launch Services (ILS). The Atlas 5's predecessors, the Atlas 2 and 3, were retired from commercial service in 2004;

- Delta 2 (medium class), built by The Boeing Company and marketed by Boeing Launch Services (BLS);

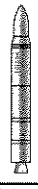
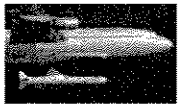
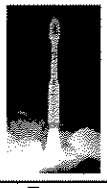
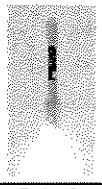
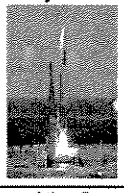
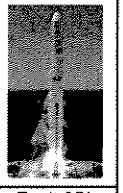
- Zenit 3SL (heavy class), built by KB Yuzhnoye (in Ukraine) for the Sea Launch partnership and marketed by BLS; and

- Pegasus XL and Taurus (small class), both built and marketed by Orbital Sciences.

Delta 4 is currently not being bid in commercial competitions. A new Delta 4 heavy version performed a demonstration launch for the Air Force in December 2004 and a heavy lift version of the Atlas 5 is under development by Lockheed Martin.

The Falcon 1, developed by SpaceX with a first launch in 2005, can carry satellites up to 454 kilograms (1,000 pounds). SpaceX intends to develop a more powerful version, Falcon 5, capable of lifting up to 4,200 kilograms (9,259 pounds) to LEO. The first stages of these vehicles are designed to be recoverable and possibly reusable.

US Commercial Orbital Launch Systems

	Small			Medium		Heavy	
							
Vehicle Name	Falcon 1	Pegasus	Taurus	Delta 2	Falcon 5	Atlas 5	Zenit 3SL
Company	SpaceX	OSC	OSC	Boeing	SpaceX	ILS	Sea Launch
First Commercial Launch	2005	1993	1998	1989	2006	2002	1999

Kistler Aerospace is developing the K-1, a two-stage reusable launch vehicle (RLV). Initially intended to deliver satellites to LEO, Kistler is repositioning the K-1 as a vehicle that can carry up to 3,200 kilograms (7,040 pounds) to the International Space Station (ISS) and return 900 kilograms (2,000 pounds) from the ISS back to Earth. Kistler is planning the first flight of the K-1 18 months after emerging from Chapter 11 bankruptcy protection, which the company has been in since July 2003.

Currently active launch vehicles licensed by the FAA for commercial suborbital launches include:

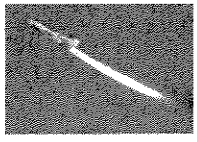
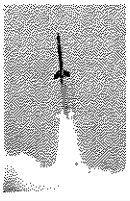
- Oriole, an expendable sounding rocket manufactured by Alliant Techsystems and provided by DTI Associates;
- SpaceShipOne, a reusable manned suborbital vehicle developed by Scaled Composites and marketed by Mojave Aerospace Ventures; and
- Terrier-Orion, an expendable sounding rocket integrated by DTI Associates using surplus government rocket motors.

Other suborbital vehicles could make launch attempts in 2005. Commercial suborbital spaceflight celebrated a number of major accomplishments in 2004. In April 2004 the FAA awarded its first licenses for commercial manned reusable spacecraft. The first license, issued April 1, went to Scaled Composites for SpaceShipOne. XCOR Aerospace received the second license on April 23 for its proposed Sphinx suborbital RLV.

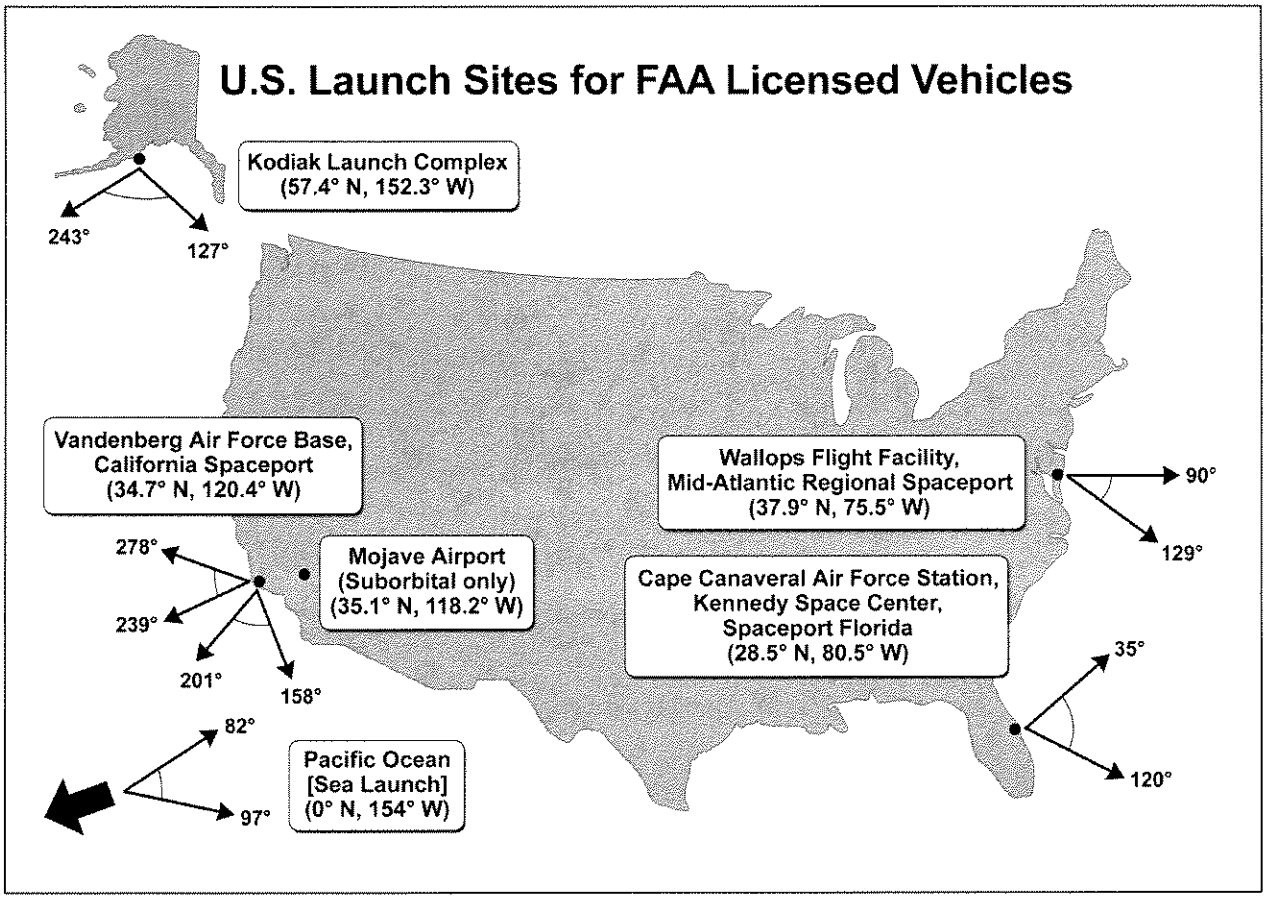
SpaceShipOne performed five licensed flights in 2004, including one on June 21, 2004, where SpaceShipOne became the first private-developed manned vehicle to fly into space, achieving a peak altitude of 100.1 kilometers (62.2 miles) during its suborbital flight. SpaceShipOne also performed manned flights above 100 kilometers on September 29 and October 4, 2004, reaching peak altitudes of 103.1 kilometers (63.8 miles) and 112.4 kilometers (69.6 miles), respectively. The latter two flights qualified for the $10-million Ansari X Prize, a competition for the first privately-developed reusable suborbital vehicle capable of carrying three people to 100 kilometers altitude twice in a two-week period. Mojave Aerospace Ventures officially received the prize on November 6, 2004.

Other companies that were developing vehicles for the Ansari X Prize are continuing their efforts, including Armadillo Aerospace, Rocketplane Ltd., Space Transport Company, and TGV Rockets. Several other companies not competing for the Ansari X Prize, such as Blue Origin, Masten Space Systems, and XCOR Aerospace, are also developing reusable suborbital vehicles for space tourism and other applications.

US Commercial Suborbital Launch Systems

Vehicle Name	Oriole	SpaceShipOne	Terrier-Orion
Company	DTI Associates	Scaled Composites	DTI Associates
First Commercial Launch	2005	2004	2001



ILS and BLS launch satellites to GEO from Cape Canaveral Air Force Station (CCAFS) in Florida. Sea Launch conducts GEO launches from a mobile ocean platform in the East-central Pacific Ocean. Launches to NGSO can take place from CCAFS, Vandenberg Air Force Base (VAFB) in California, the Mid-Atlantic Regional Spaceport in Virginia, or Kodiak Launch Complex in Alaska (see figure "U.S. Launch Sites," above).

FAA/AST has issued five launch site operator licenses to state-run organizations to operate commercial launch sites, or spaceports. They are:

- Spaceport Florida at CCAFS, Florida (license held by Florida Space Authority);
- California Spaceport at VAFB, California (license held by Spaceport Systems International);
- Mid-Atlantic Regional Spaceport at Wallops Island, Virginia (license held by Virginia Commercial Space Flight Authority);
- Kodiak Launch Complex on Kodiak Island, Alaska (license held by Alaska Aerospace Development Corporation), the first spaceport not located on a federal range; and
- Mojave Airport in Mojave, California (license held by East Kern Airport District), for suborbital launches. This is the first inland licensed launch site.

Other states are actively seeking to develop additional spaceports, including Oklahoma, New Mexico, and Texas.

REVIEW OF 2004

There were 14 FAA-licensed launches—nine orbital and five suborbital—in 2004, up from eight in 2003. ILS carried out five Atlas launches, all from Cape Canaveral. Sea Launch conducted three successful launches of GEO communications satellites from their Pacific Ocean platform, and Orbital Sciences Corporation conducted a successful launch of the Taurus launch vehicle for Taiwan. There were also five suborbital flights of Scaled Composites' SpaceShipOne vehicle.

Russian launch ranges deployed five vehicles for commercial missions. Europe's Arianespace conducted only one commercial launch from Kourou in French Guiana, their lowest total since the company was founded. Therefore, including the six launches from U.S. ranges and the three flights for Sea Launch, a total of 15 orbital commercial launches were conducted during 2004. There were 54 total worldwide commercial, civil, and military launches, the lowest total since 1961, with commercial launches representing about 30 percent of total launches. For more details, see the Year in Review report available from the FAA/AST website at *http://ast.faa.gov/rep_study/yir.htm.*

COMMERCIAL SPACE TRANSPORTATION FORECASTS

In May 2004, the FAA and the Commercial Space Transportation Advisory Committee (COMSTAC) published their annual forecast for commercial launch demand, the *2004 Commercial Space Transportation Forecasts.* This forecast combined the *COMSTAC 2004 Commercial Geostationary Launch Demand Model,* which covers satellites that operate in GEO, with the FAA's *2004 Commercial Space Transportation Projections for Non-Geosynchronous Orbits (NGSO).* The forecast projected an average of about 23 commercial orbital launches worldwide annually through 2013.

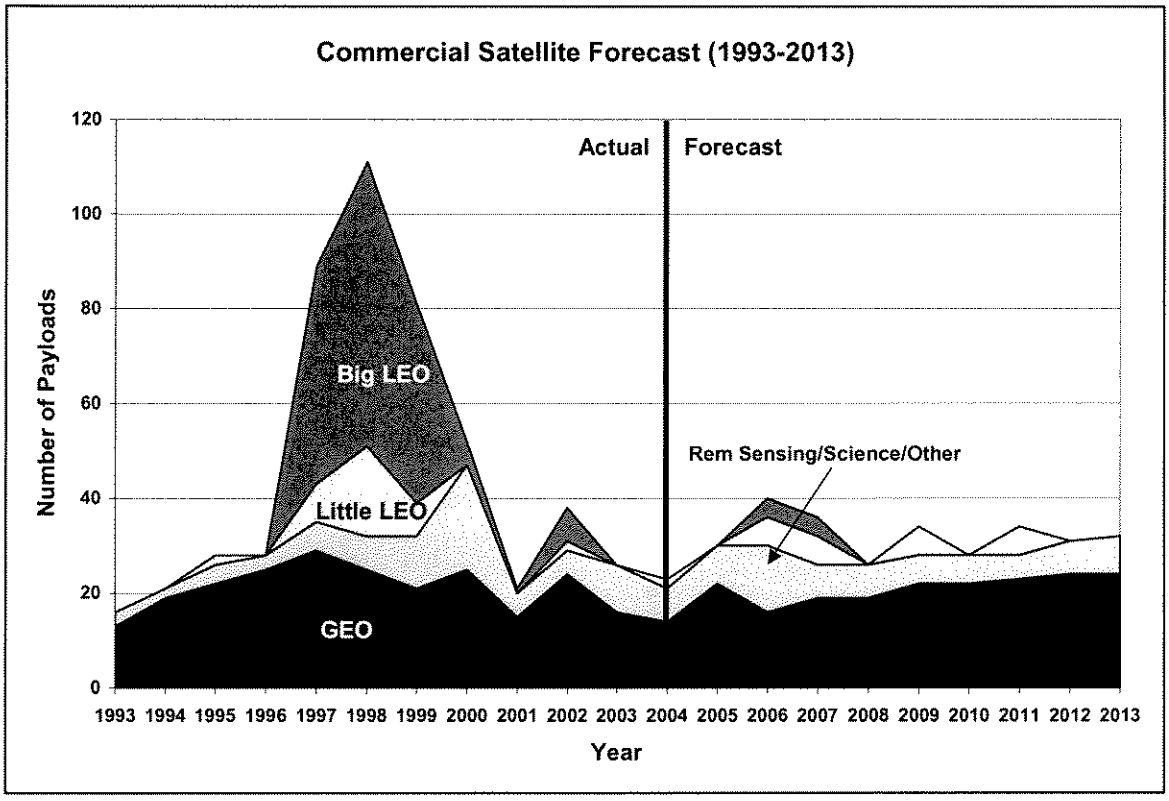
The 2004-2013 forecasts project an annual average of:

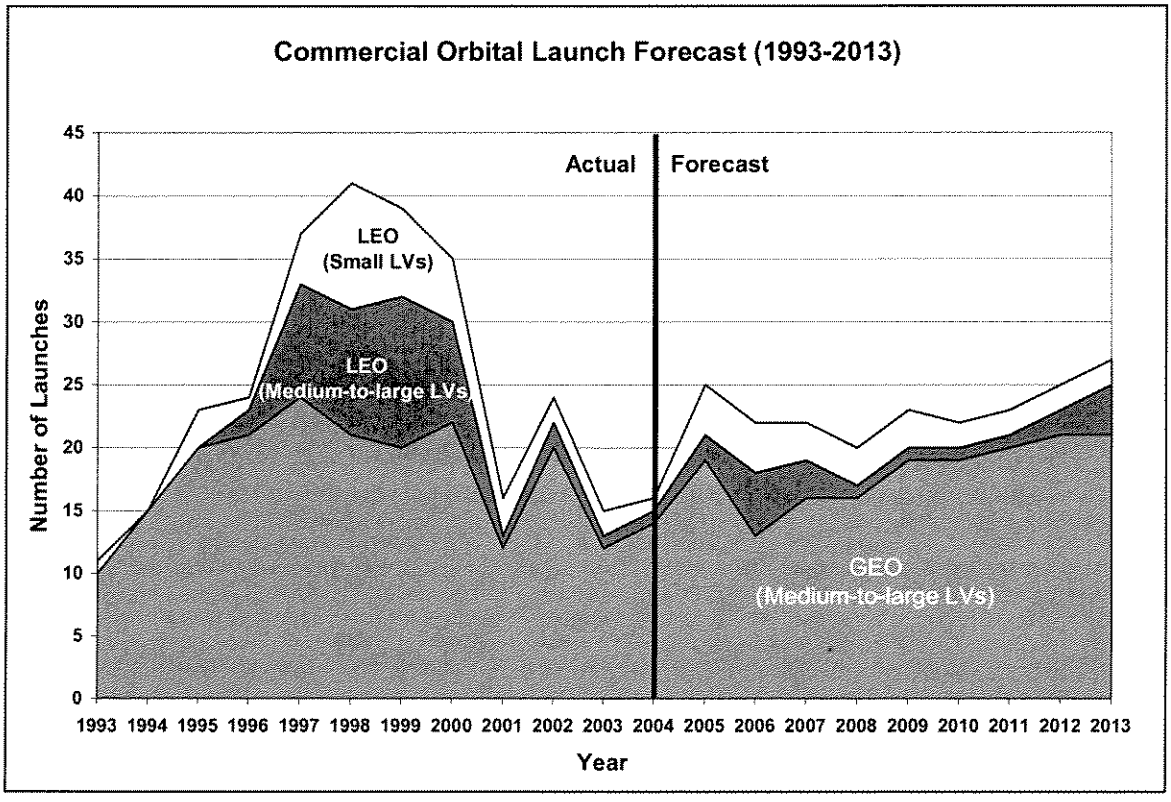
- 18.3 launches of medium-to-heavy vehicles to deploy GEO satellites;
- 2.3 launches of medium-to-heavy vehicles to NGSO; and
- 2.8 launches to NGSO by small vehicles.

These estimates account for multiple manifesting payloads, since commercial NGSO payloads could be launched in groups to reduce launch costs.

The GEO and NGSO forecasts are not a prediction of what will actually be launched. Instead, they represent the demand for launch services for actual or projected satellite programs in a given year, based on inputs from industry, government, and other sources.

The GEO forecast, compiled by COMSTAC, is based on responses to questionnaires from satellite manufacturers, satellite operators, and launch service providers in the U.S. and other nations. The ten-year mission model consists of a near-term manifest that identifies specific payloads scheduled for launch during the first three years of the forecast (2004–2006), as well as a long-term demand forecast that estimates demand for payloads and launches for the remaining years (2007–2013). The GEO forecast also includes a "realization factor" that estimates the number of launches that will actually take place during the near-term portion of the model, to take into account the variance between forecasted demand and actual launches because of satellite and launch vehicle delays.


Commercial Satellite Forecast (1993-2013)
Actual
Forecast
Big LEO
Little LEO
GEO
Rem Sensing/Science/Other
Number of Payloads
Year
0
20
40
60
80
100
120
1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013


Commercial Orbital Launch Forecast (1993-2013)
Actual
Forecast
LEO
(Small LVs)
LEO
(Medium-to-large LVs)
GEO
(Medium-to-large LVs)
Number of Launches
Year
0
5
10
15
20
25
30
35
40
45
1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013

The NGSO forecast examines three major markets for commercial launch services: telecommunications, commercial remote sensing, and international science and other payloads. Representatives of these markets, as well as launch service providers and other sources, are queried about their plans for specific satellite systems throughout the forecast period. This information is used to assemble a near term manifest (2004-2007) for identified payloads and launches. Because some of these systems, particularly in the international science sector, have short timelines, demand for future launches is projected based on past experience and current trends. Replacement of existing telecommunications and remote sensing systems is also included in the forecast based on lifetimes of existing systems.

Several factors can affect the forecast, including satellite manufacturing delays, launch vehicle component problems, launch failure investigations, or manifesting issues. Regulatory issues, such as satellite export compliance or FCC licensing, can come into play. Also, changes in the business environment can cause satellite companies to alter or cancel their development plans.

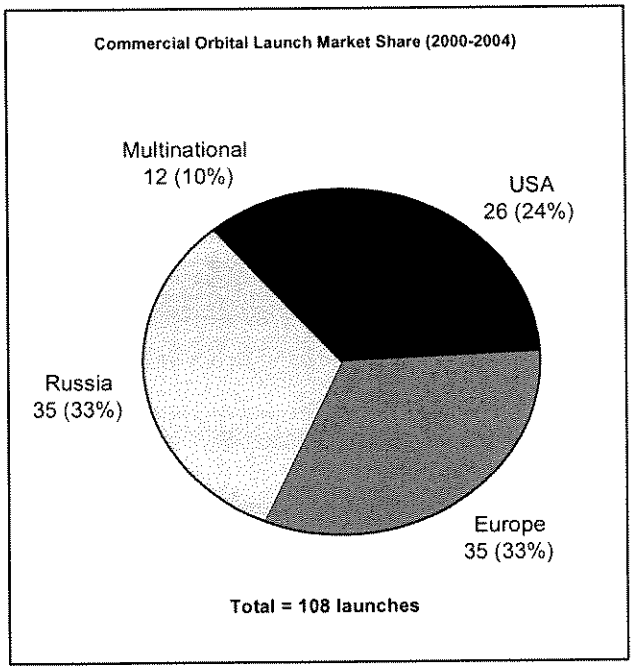
The complete forecast report is available at *http://ast.faa.gov/rep_study/forcasts_and_reports.htm*.

GENERAL TRENDS

The dominant feature of the commercial launch industry continues to be the launch of commercial satellites to GEO. There are also a small number of commercial launches to NGSO for remote sensing and international science payloads, but NGSO launches make up a considerably smaller portion of the market today then during the deployment phase of Iridium and Globalstar in the late 1990s. The NGSO telecommunications market has declined significantly. The 2004 forecast projects the composition of NGSO payloads to be about 55 percent international science and research and 15 percent remote sensing. The remaining 30 percent of NGSO payloads will be telecommunications satellites, although these will serve to replenish existing satellite constellations rather than deploy new systems. Only 2 of 16 commercial launches during 2004 contained NGSO payloads.

The commercial market generally has experienced a sharp decline in demand due to the global economic slowdown and business failures of first generation mobile telecommunications companies. Launch activity is expected to grow only gradually over the next several years. U.S. commercial providers hope that new government markets open up, such as resupply of the International Space Station.

The global marketplace continues to have a surplus in commercial launch capacity. The largest providers of commercial launch services in the United States, Europe, and Russia continue to operate fewer launches than in the recent past. New efforts to offer commercial services from Japan and Brazil have slowed because of vehicle failures and a generally crowded marketplace. As the chart below shows, Europe and Russia have each taken approximately one third of the total commercial launch market over the last five years, with the remaining third split between U.S. vehicles and the multinational Sea Launch venture.



The success of SpaceShipOne and the Ansari X Prize has helped open a new market for commercial space transportation: public space travel or space tourism. In September 2004, shortly before the first of the two SpaceShipOne Ansari X Prize flights, the Virgin Group announced that it would license SpaceShipOne technology from Mojave Aerospace Ventures for use on a new reusable suborbital vehicle, to be built by Scaled Composites. Up to five such vehicles will be operated by Virgin Galactic, a Virgin subsidiary, to provide suborbital space tourism flights for approximately $200,000 a person starting in 2007. In addition to space tourism, other markets that may be serviced by commercial suborbital spaceflight in the near term include remote sensing, high-altitude and microgravity research, and microsatellite insertion.

The X Prize Foundation intends on following up its prize competition with an annual competition similar to the air races of the early 20th century. The X Prize Cup, slated to begin in 2006 in New Mexico, will feature commercially-developed suborbital vehicles competing in a number of categories, including maximum altitude and fastest turnaround time between flights.

The Ansari X Prize has also generated interest in similar prize competitions designed to stimulate commercial space transportation. In the fall of 2004 Robert Bigelow, founder of Bigelow Aerospace, unveiled plans for America's Space Prize, a $50-million award for a commercial manned orbital vehicle. The prize, which expires on January 10, 2010, would go to the first commercially-developed U.S. vehicle capable of carrying five people launched into orbit twice within 60 days. The vehicle must also be capable of docking with inflatable orbital habitats being developed by Bigelow Aerospace.

NASA also started its own prize program, Centennial Challenges, during 2004. Although NASA is still developing the details of the program, as well as seeking Congressional authorization to offer prizes larger than $250,000, the agency plans to offer prizes for both specific technologies as well as full-scale missions, such as a robotic lunar lander or a solar sail. These prizes may stimulate additional demand for commercial space transportation.

Centennial Challenges is part of NASA's Vision for Space Exploration (VSE), the agency's new space exploration policy unveiled by President George W. Bush on January 14, 2004. The VSE calls for retiring the Space Shuttle by 2010, when the ISS is completed, and developing a new manned spacecraft, the Crew Exploration Vehicle (CEV), that would be used for missions to Earth orbit and beyond, including a lunar landing by 2020. The VSE calls on NASA to "pursue commercial opportunities for providing transportation and other services supporting the International Space Station and exploration missions beyond low Earth orbit." This recommendation was supported by the President's Commission on the Implementation of United States Space Exploration Policy, which in June 2004 suggested that prizes, tax incentives, and other tools be used to support transportation and other aspects of a "true space industry" in the U.S.